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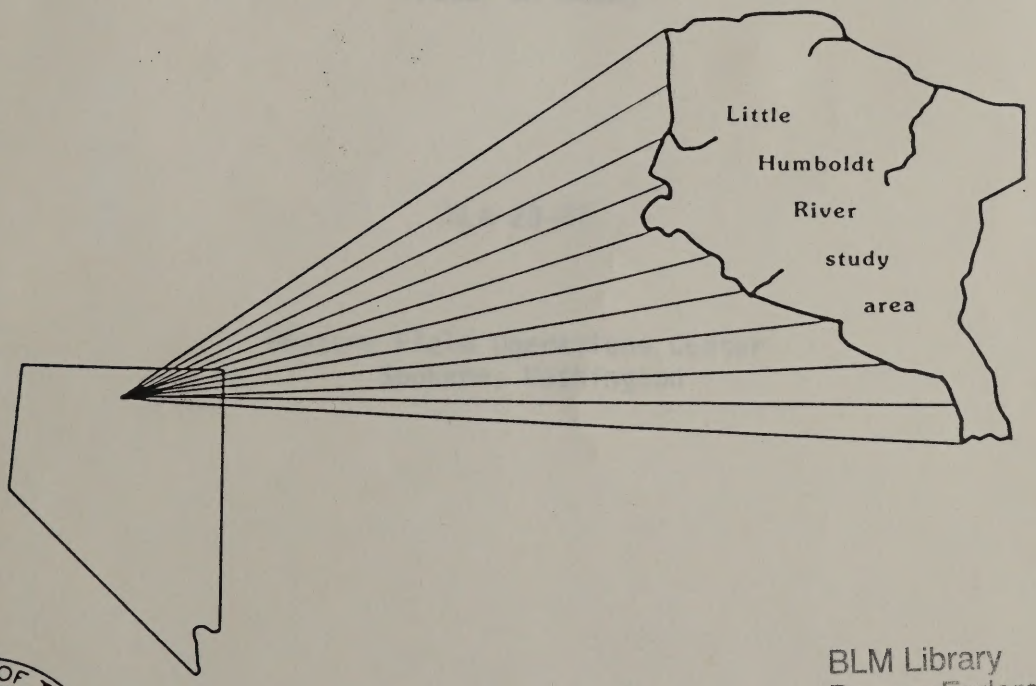
Open File Report

Mineral Resources of the Little Humboldt River Study Area, Elko County, Nevada



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MINERAL RESOURCES OF THE LITTLE HUMBOLDT RIVER STUDY AREA, ELKO COUNTY, NEVADA

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MLA 23-87

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PREFACE

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on U.S. Bureau of Land Management administered land designated as Wilderness Study Areas ". . . to determine the mineral values, if any, that may be present . . . ." Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a Bureau of Mines mineral survey of a portion of the Little Humboldt River Wilderness Study Area (NV 010-132), Elko County, NV.

This open-file report will be summarized in a joint report published by the U.S. Geological Survey. The data were gathered and interpreted by Bureau of Mines personnel from Western Field Operations Center, East 360 Third Avenue, Spokane, WA 99202. The report has been edited by members of the Branch of Mineral Land Assessment at the field center and reviewed at the Division of Mineral Land Assessment, Washington, DC.

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SUMMARY

A mineral survey of 40,000 acres of the 42,213-acre Little Humboldt River Wilderness Study Area was conducted by the U.S. Bureau of Mines in 1985 at the request of the U.S. Bureau of Land Management. There are no identified mineral resources but anomalous gold, silver, mercury, and arsenic concentrations were found. The study area is located in Elko County, NV, in the Owyhee Upland geomorphic subprovince. It is underlain by mid- to late-Miocene-age rhyolite, basalt, tuff, vitric ash, and tuffaceous siltstone.

On the south side and partly within the study area, a mining company recently (January 1986) located 125 contiguous claims over an area of hydrothermally-altered volcanic rocks that have anomalous surface concentrations of gold, mercury, arsenic, and silver. Anomalous gold-silver concentrations in altered rocks were encountered at several other widely scattered localities in the study area. These elevated metal concentrations and associated hydrothermal alteration indicate gold resources may be present in the study area. A 20-ft-thick bed of diatomaceous earth, which contains 60 to 85 percent diatoms, crops out 0.3 mi north of the study area. Elsewhere, three samples of altered volcanic tuff taken within the study area contain from 46 to 70 percent zeolite (clinoptilolite). The diatomaceous earth and zeolite sampled are not of sufficient quality to compete with materials presently being marketed. There has been no mineral production from the study area, but a caved adit, about 25 ft long, and six prospect pits were found.

INTRODUCTION

This report describes the USBM (U.S. Bureau of Mines) portion of a cooperative study with the USGS (U.S. Geological Surevey) to evaluate mineral resources and potential of a portion of the Little Humboldt River WSA 1/ (Wilderness Study Area) at the request of the BLM (Bureau of Land Management). The USBM examines individual mines, prospects, claims, and mineralized zones, and evaluates identified mineral and energy resources. The USGS evaluates potential for undiscovered resources based on areal geological, geochemical, and geophysical surveys. Results of the investigations will be used to help determine the suitability of the study area for inclusion into the National Wilderness Preservation System. The immediate goal of this report is to provide data for the President, Congress, the BLM, and the general public for land-use decisions. The long-term objective of this and other USBM studies is to ensure the Nation has an adequate and dependable supply of minerals at a reasonable cost.

1/ A WSA is a roadless area or island that has been inventoried by the U.S. Bureau of Land Management and found to have wilderness characteristics as described in Section 603 of the Federal Land Policy and Management Act of 1976 and Section 2(c) of the Wilderness Act of 1964 (78 Stat. 891).

Setting

The Little Humboldt River study area encompasses 40,000 acres of the 42,213-acre WSA in north-central Nevada, approximately 45 mi (mile) north of Battle Mountain, NV (fig. 1). It is an area of rolling Owyhee volcanic uplands broken by the Snowstorm Mountains to the southwest, Castle Ridge on the east, and an unnamed ridge to the south. These topographic heights surround a basin that drains to the north and is dissected by narrow canyons up to 500 ft (feet) deep. Elevations range from 5,050 ft on the Little Humboldt River at the northern boundary of the study area to 7,320 ft on Castle Ridge on the southeastern boundary.

Access to the southern end, and to the west and north sides of the study area, is by poor-quality dirt roads. Some rugged jeep trails are along fence lines into the study area. Midas, NV, is a 9 mi drive on dirt roads from the south boundary of the study area (fig. A-1).

Previous Studies

Stratigraphy and geologic structure in the study area and vicinity were described by Hope and Coats (1976) in a preliminary geologic map of Elko County. Geology to the west of the study area, in Humboldt County, was reported in Willden (1964). A study of geology, energy, and mineral (GEM) resources by Mathews and Blackburn (1983) and a reconnaissance geochemical survey by Tingley and Quade (1984) were contracted by the BLM as preliminary assessments of the WSA. The study area also falls within the scope of the Department of Energy NURE (National Uranium Resource Evaluation) study of the McDermitt and Wells 1° by 2° quadrangles (Jones and Fay, 1980).

The first detailed description of the geology of the nearby Gold Circle mining district appears in Emmons (1910); the next update and first comprehensive petrographic study was by Rott (1931). A report by Smith (1976) was used in this report for the geologic description of the district. Lincoln's (1923) "Mining districts and mineral resources of Nevada" contains a description of geology and history of the Gold Circle mining district and a comprehensive bibliography of early publications and obscure technical-journal articles concerning the region containing the study area. These include early reports by Ryan (1911), Dougan (1915), Young (1918), Dorr and Dougan (1919), and Weed (1922) on mining and milling operations in the district.

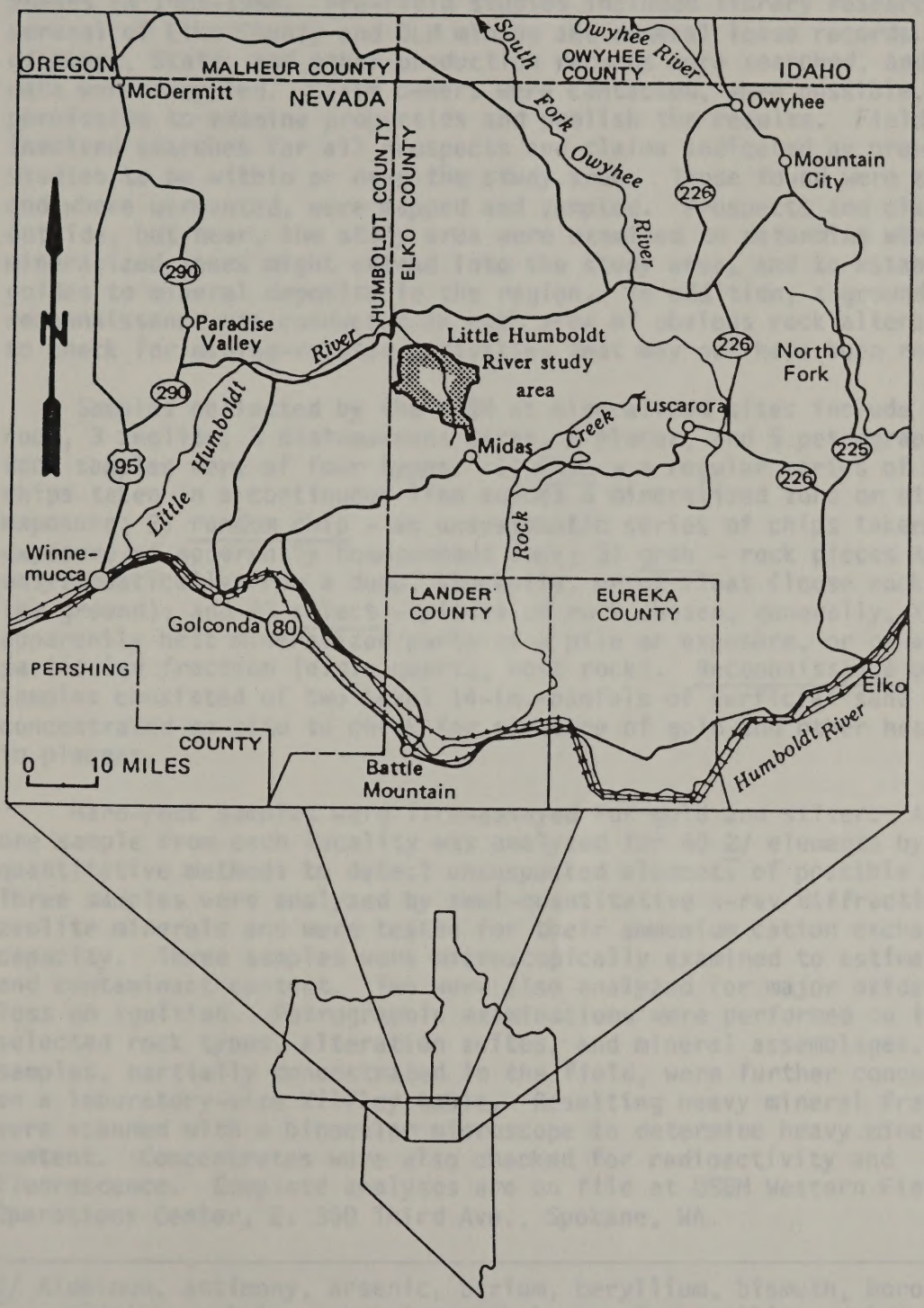

FIGURE 1. – Location of the Little Humboldt River study area, Elko County, NV

Present Study

Work by the USBM entailed pre-field, field, and report preparation phases in 1985-1986. Pre-field studies included library research and perusal of Elko County and BLM mining and mineral lease records. Bureau of Mines, State, and other production records were searched, and pertinent data were compiled. Claim owners were contacted, when possible, for permission to examine properties and publish the results. Field studies involved searches for all prospects and claims indicated by pre-field studies to be within or near the study area. Those found were examined, and where warranted, were mapped and sampled. Prospects and claims outside, but near, the study area were examined to determine whether mineralized zones might extend into the study area, and to establish guides to mineral deposits in the region. In addition, a ground reconnaissance was conducted in each area of obvious rock alteration to check for mining-related activities that may not have been recorded.

Samples collected by the USBM at mineralized sites include 47 hard-rock, 3 zeolite, 3 diatomaceous earth, 5 placer, and 5 petrographic. Rock samples were of four types: 1) Chip - a regular series of rock chips taken in a continuous line across a mineralized zone or other exposure; 2) random chip - an unsystematic series of chips taken from an exposure of apparently homogeneous rock; 3) grab - rock pieces taken unsystematically from a dump, stockpile, or of float (loose rock lying on the ground); and 4) select - pieces of rock chosen, generally, from the apparently best mineralized parts of a pile or exposure, or of any particular fraction (e.g., quartz, host rock). Reconnaissance placer samples consisted of two level 14-in.-panfuls of surficial sand and gravel concentrated on site to check for presence of gold and other heavy minerals in placers.

Hard-rock samples were fire-assayed for gold and silver. At least one sample from each locality was analyzed for 40 2/ elements by semi-quantitative methods to detect unsuspected elements of possible significance. Three samples were analyzed by semi-quantitative x-ray diffraction for zeolite minerals and were tested for their ammonium cation exchange capacity. Three samples were microscopically examined to estimate diatom and contaminant content. Two were also analyzed for major oxides and loss on ignition. Petrographic examinations were performed to identify selected rock types, alteration suites, and mineral assemblages. Placer samples, partially concentrated in the field, were further concentrated on a laboratory-size Wilfley table. Resulting heavy mineral fractions were scanned with a binocular microscope to determine heavy mineral content. Concentrates were also checked for radioactivity and fluorescence. Complete analyses are on file at USBM Western Field Operations Center, E. 360 Third Ave., Spokane, WA.

2/ Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, gallium, gold, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, palladium, phosphorus, potassium, platinum, scandium, silicon, silver, sodium, strontium, tantalum, tellurium, tin, titanium, vanadium, yttrium, zinc, and zirconium.

A mining company supplied the USBM with preliminary geologic data from the CR claim group, which covers the southeastern portion of the study area. The data consisted of a geologic map; a rock alteration map; 65 geochemical rock sample analyses; and 261 reconnaissance geochemical stream-silt sample analyses, of which 78 samples are from within or adjacent to the study area.

In this report the term "occurrence" is used as defined in Circular 831 (U.S. Bureau of Mines and U.S. Geological Survey, 1980): occurrences -- materials that are too low grade or for other reasons are not considered potentially economic. The term "anomalous" is used as defined by Levinson (1974, p. 216): anomalous -- geochemistry concentrations deviating or departing from the norm for the region. In this report the term will only be used for elevated, minor, metal contents, which may indicate the presence of mineral resources.

GEOLOGIC SETTING

The Little Humboldt River study area is in the southwestern part of the Owyhee Upland geomorphic subprovince of the Columbia Intermontane province. According to Thornbury (1965, p. 463-464), features that distinguish the Owyhee Upland from the High Lava Plain subprovince to the north are its older lavas, dominantly rhyolite and quartz dacite lavas, and being an area structurally upwarped. Because doming rather than faulting is the dominant structural feature, the Uplands lack the typical isolated mountain ranges and adjacent intermontane basins of the adjoining Basin and Range province.

In the vicinity of the study area, the Cenozoic volcanic rocks may exceed 3,000 ft in thickness (Vikre, 1985, p. 361). The study area is underlain by mid- to late-Miocene rhyolite flows and domes, olivine basalt, andesite, tuff, vitric ash, and tuffaceous siltstone (Hope and Coats, 1976). Tuff and ash layers are commonly zeolitized, and tuffaceous siltstone just north of the study area contains a 20-ft-thick diatomaceous bed. Volcanic rocks and interbedded sediments north of the study area are relatively flat-lying. Deformation of the rocks within the study area has resulted in beds with gentle to moderately steep dips (some attitudes may be due to location on the flanks of rhyolite domes) and two dominant sets of faults, one trending northwest and the other east-northeast.

The volcanic rocks found inside the study area were mapped by Hope and Coats (1976) as being younger than the volcanic rocks hosting the deposits in the Gold Circle mining district, south of the study area. Hydrothermal alteration in the district is pervasive, covering a surface area about 10 mi^2 (square mile) (Smith, 1976, p. 72) and extends into the study area. The rhyolite is leached and bleached to a chalky-looking rock containing calcite, sericite, adularia, and streaks of limonite stain. Rocks of basic composition are altered to serpentine, calcite, quartz, chalcedony, and kaolin. Ore bodies in the Gold Circle district are quartz veins deposited in open fissures, sheeted zones, and breccia zones along northwest- and northeast-striking faults in rhyolite or along the

contact of the rhyolite with andesite. In addition to the quartz, the ore bodies also contain chalcedony and pyrite; small amounts of calcite, chlorite, and adularia; and ore minerals of native gold and silver and various silver and base metal sulfides. Vein adularia has been dated at 15.0 ± 0.4 m.y. (million years ago), and the basaltic andesite has been dated at 15.1 ± 1.6 m.y. (Alan R. Wallace, oral commun., 1985).

The USGS examined a zunyite deposit 9 mi east of the study area (Coats and others, 1979), and two zeolitic-tuff outcrops 3 mi northwest of the study area (Sheppard and Gude, 1983). Besides its use as a refractory material, Coates and others (1979) also mention zunyites association with fluorspar deposits and its presence in zones of advanced argillic alteration associated with precious and base metal deposits.

MINING AND PROSPECTING HISTORY

The earliest mineral find in the vicinity of the study area (approximately 30 mi east) was the discovery of placer gold in the Tuscarora mining district in 1867, followed in 1871 by the discovery of lode silver-gold (Granger and others, 1957, p. 151). Ten historic mining districts lie within 35 mi of the study area: Gold Circle, on the study area's southern boundary; Burner, Good Hope, Cornucopia, Rock Creek, and Ivanhoe to the east (Granger and others, 1957, plate 2 and 3); Lynn to the south (Hill, 1912, p. 200, plate 9); and Potosi, Dutch Flat, and Poverty Rock to the southwest and west (Vanderburg, 1938; Willden, 1964, plate 3). Besides gold and silver, these districts have produced copper, lead, zinc, mercury, manganese, and tungsten.

The initial gold discovery in the Gold Circle district was made in 1907. Six or more mills, ranging in capacity from 25 to 75 tons per day were operated. The largest operation in the district, the Elko Prince mine and mill, produced about 95,000 oz (troy ounces) of gold and 1.5 million oz of silver and is located 2.5 mi southeast of the study area. Production from the entire Gold Circle district, from 1908 to 1965, was 300,000 to 400,000 tons of ore that yielded about 127,000 oz of gold and 1.6 million oz of silver. None came from the study area.

Because of the current profitability of gold mining, and the success of exploration programs in northern Nevada, there presently (1985) is a very high level of interest and exploration activity in the vicinity of the study area. Twelve deposits have been located in recent years within 35 mi of the study area: Ivanhoe, Dexter (Tuscarora), Dee, Bootstrap, Carlin, Blue Star, Bullion Monarch, Goldstrike, Genesis, Getchell, Pinson, and Preble. These deposits are at various stages in the life cycle of a mine, from drilling program to producing mine, and have total resources in the range of 90 million tons containing 10 million oz of gold (Lowe and others, 1985). Seven are currently producing, with a combined total 1985 production of over 250,000 oz of gold. The nearest active mine to the study area is the Pinson, 22 mi to the southwest. Exploration programs are presently in progress in the Gold Circle mining district to the south and in the study area, in the Scraper Springs area near the eastern border of the study area, and the Snowstorm Mountain area where claims were being located up to the western border of the study area.

In 1907 and 1908, claims were located up to 1.5 mi north of Brush Creek and along Snowstorm Creek. A short, caved adit and several prospect pits were found in the area north of Brush Creek. At the beginning of 1985, only part of one current claim was within the study area. A corner of the Snow No. 10 claim, owned by Fred Barnes, overlaps the boundary where Snowstorm Creek enters the study area. While field work was in progress (mid-June, 1985), Freeport-McMoran and Callahan Mining Corp. were locating large areas on the northeast flank of the Snowstorm Mountains with claim groups extending to the study area boundary. In January 1986, a mining company located 125 contiguous claims in secs. 30 and 31, T. 40 N., R. 46 E., within the study area, and secs. 19, 20, 29, and 32, adjacent to and partially within the study area (fig. 2, CR claim group). The Red claim group, owned by T. R. Iverson, and the JMC claim group, owned by Joshua Mining Company, lie adjacent to the CR claim group less than 1 mi from the southern boundary of the study area. ASARCO, Freeport Exploration, Newmont Exploration, and U.S. Steel have been locating claims and conducting exploration 5 to 9 mi east of the study area.

Two and a half miles north of the study area, the southern half of T. 42 N., R. 45 E. is covered by oil and gas leases (Virginia Carmichael, personal commun., 1986). Thirty-six miles northeast of the study area, the Bull Run Oil and Gas Co. in 1922 drilled an 800-ft well in the Bull Run Mountains (Lintz, 1957, p. 40-41) and reported the presence of oil and gas, but in 1956 Richfield Oil Corp. drilled a nearby 3,386-ft hole, with no reported shows (Garside and Schilling, 1977).

MINES, PROSPECTS, CLAIMS, AND MINERALIZED AREAS

Metallic Minerals

CR Claim Group

The CR claim group covers approximately 4 mi^2 of the western slope of Castle Ridge (fig. A-1), partly in the study area. Access to the southern and eastern sides of the claimed area is by a 3 mi drive north from Midas on jeep trails, then a short hike over moderately-steep slopes.

The claim group is centered on a cluster of broad ridges, hills, and knobs that buttress Castle Ridge and are part of a north-northwest trending, structurally-uplifted block. Uplift and erosion have exposed over 2 mi^2 of altered volcanic rocks composed predominantly of rhyolite tuffs, flows, domes, flow breccias, and some tuffaceous sediments. Andesitic rocks occur in the southern part of the claim group (see appendix fig. A-2). Broad areas of siliceous volcanic rocks, which are oxidized and exhibit weak argillic alteration, and andesitic rocks, which exhibit propylitic alteration, form an irregular-shaped, north-northwest-trending zone which averages 3,000 ft wide (see appendix fig. A-3). No attempt has been made to map the alteration zone beyond the north perimeter of the claim group, into the study area. Commonly superimposed on the

large, weak-intensity, alteration zone are zones of weak to strong quartz veining, pervasive silicification, and pervasive, fracture-controlled alunite deposition. There are also several zones of bleached rocks west of the alteration zones (see appendix fig. A-3). Some disseminated pyrite was seen at two localities in areas showing strong quartz veining.

A 25-ft-long caved adit and five pits were found on the claim group within the study area. The localities of 7 samples (nos. 37-43) taken by the USBM are shown on figure 2; sample descriptions and analyses are listed in table 1. Of the seven samples, five had detectable gold, four with concentrations from 23 to 45 ppb (parts per billion) and one with 218 ppb; and two had detectable silver with concentrations of 0.520 and 0.740 ppm (parts per million). Preliminary geochemical data supplied by a mining company are interpreted by the USBM to delineate broad areas with anomalous concentrations of gold, mercury, and arsenic (see appendix figs. A-4, A-5, and A-6). The company's detailed exploration program was conducted after anomalous gold concentrations were found during a reconnaissance stream-silt survey. One silt sample from Brush Creek contained 8 ppb gold, and another from the intermittant drainage to the north contained 6 ppb gold (see appendix fig. A-1). These concentrations are above background amounts for silt derived from the type of rocks present.

Snow Claim Group

The Snow Nos. 1, 2, 3, 8, 9, and 10 claims were located along Snowstorm Creek in 1980 by Fred Barnes of Golconda, NV. A small part of Snow No. 10 is in the study area (fig. A-1). Three prospect pits are on the south boundary of the claim group.

Widespread, gradational, hydrothermal alteration of rhyolitic and andesitic rocks was observed at the prospect pits and for 1.4 mi to the northeast, extending into the study area. The alteration and mineralization are manifested as light-colored, bleached, and silicified volcanic rocks with gray and white quartz veinlets, quartz-cemented breccia, and oxidized, disseminated pyrite. Greenish (propylitic alteration?), silicified volcanic rocks with some oxidized, disseminated pyrite were seen along Snowstorm Creek and into the study area. The intensity and type of silicification down Snowstorm Creek grades from abundant to less abundant white quartz veinlets, jasper, and quartz cemented breccia, and finally to only bands and blebs of chalcedony inside the study area.

The localities of six rock samples (nos. 19-24) taken from the claim group are shown on figure 2; sample descriptions and analyses are listed in table 1. The only ore grade assay (sample 21), 5.599 ppm gold and 119 ppm silver [0.163 oz/ton (troy ounce per ton) gold and 3.5 oz/ton silver], came from a prospect pit 1.2 mi outside the study area. Of the five remaining rock samples, four had detectable gold with concentrations from 21 to 48 ppb, and one had detectable silver with a concentration 1.744 ppm. Two placer samples from Snowstorm Creek contained traces of scheelite (a tungsten mineral) but no detectable gold.

JMC and Red Claim Groups

To the south of the study area, a 35-ft-long adit and eight prospect pits on the JMC claim group and the Red claim group were examined to determine if mineralized zones might extend into the study area. The JMC group was located in 1980 and 1981 by Joshua Mining Company of San Francisco, CA, and the Red group was located in 1979 by T. R. Iverson of Lovelock, NV. To reach the area examined is a drive of 2.5 to 3 mi north from Midas on jeep trails.

The claimed area is underlain predominantly by andesitic and rhyolitic volcanic rocks and appears to be the southern extension of the broad zone of pervasive propylitic and argillitic alteration found on the CR claim group. Silicification, quartz veining, and quartz-cemented breccias are localized and commonly found at workings. Also, disseminated pyrite was observed in both breccias and silicified material.

The localities of ten samples (nos. 44-53) from the north end of the claim groups are shown on figure A-1, and sample descriptions and analyses are listed in table 1. Seven samples had detectable gold, six with concentrations from 19 to 25 ppb and one with 359 ppb; and three had detectable silver concentrations from 0.420 to 1.901 ppm. No samples had ore grade concentrations.

Other Metallic Mineral Occurrences

Outcrops of altered and silicified material inside the study area but outside the claimed areas were examined by the USBM, and 24 samples were taken. Sample localities are shown on figure A-1, and descriptions and analyses are listed in table 1. The four highest gold concentrations are from samples 17, 27, 28, and 34, all of which were taken of altered and silicified material at contacts between dark-greenish, andesitic volcanic rock and red rhyolite. Samples 28 and 34 are of material suggesting a mineralized breccia sill -- poorly sorted, angular to subrounded, altered fragments in a cementing matrix of fine-grained quartz (and specular hematite?), with the fragments often being entirely surrrounded by the matrix minerals (Polovina, 1984). Hydrothermal fluids under pressure from mineralized breccia pipes located to the south may have spread laterally along a permeable horizon at the rhyolite/andesite contact.

Two level 14-in. panfuls of surficial silt, sand, and gravel were taken at five locations shown on figure A-1. All five samples contained a trace of scheelite (a tungsten mineral). The sample from Oregon Canyon, outside the study area, contained gold. The gold was subangular and represented $0.06 gold per cubic yard (at gold price of $350 per oz).

The 78 stream-sediment silt samples taken by a mining company (shown on appendix figure A-1) were part of a 261 sample regional study covering about 275 mi^2. The study first identified drainages with anomalous metal concentrations that may be associated with disseminated gold. More-detailed follow-up work was then done to locate the in-place source of the anomalous concentrations. Four silt samples from inside

the study area contained anomalous gold, three contained anomalous mercury, and three contained anomalous arsenic. Of special interest is the sample with 20 ppb gold from the drainage north of First Creek (see appendix fig. A-1). This unusually high concentration (above the 95th percentile) indicates that a near-surface gold resource may be present to the southwest or west, inside the study area.

Industrial Minerals

Diatomite Occurrence

An outcrop of diatomite approximately 20 ft thick is at the northwest end of Rodear Flat, 0.3 mi north of the study area. Diatomite is a light-colored, siliceous, sedimentary rock which consists of microscopic remains of diatoms -- one-celled aquatic plants related to algae. Useful characteristics, primarily due to the siliceous diatom skeletons, are a high surface area, high absorptive capacity,and relative chemical stability. Processed diatomite has numerous industrial applications, with filter aid uses accounting for over half of current consumption (Kadey, 1983, p. 677).

The outcrop, the only exposure of diatomaceous material seen, is a large area of light-colored, fine-grained, powdery material sloughing down a gentle slope on a low-lying ridge. Three samples were taken--two of relatively fresh diatomite from the top of the light colored area and one from the entire exposure. Sample localities are shown on figure 2. Preliminary characterization and chemical analyses of the samples are summarized in tables 2 and 3.

Rodear Flat appears to be a small, structurally-controlled basin bound on the north by a fault which may have defined the northern limit of the fresh water lake that produced the diatomite bed. This limits the possible extension of the diatomite to the north to less than 1,000 ft. The lack of other outcrops in the area also suggests the bed is thinning to the north. The diatomite bed is estimated to be a triangular-shaped, tabular body averaging 7 ft thick and inferred to contain 43,000 tons, with a 60 to 85 percent diatom content. Maximum overburden is estimated to be 100 ft. There was no evidence the diatomite bed extends south to the study area and the diatomite does not constitute a resource.

Zeolite Occurrences

Zeolite occurrences in the study area were examined at three localities along the Little Humboldt River. Zeolites are hydrated aluminosilicate minerals. Because of the structural features and chemical properties of these minerals, different zeolites with corresponding different alumosilicate frameworks can act as ion or molecular sieves, each having a characteristic use (Deer and others, 1976, p. 393-395). Presently, zeolites are being used for pollution control, water purification, radioactive waste disposal, soil conditioners, animal feed supplements, animal absorbents (kitty litter), deodorizers, catalysts, and drying agents for freon refrigeration equipment (Eyde, 1986, p. 369).

The zeolite-rich outcrops in the study area are light colored, altered, porous, volcanic tuffs with a slight greenish cast, and they are presumed to be stratiform bodies of unknown extent. Sample localities are shown on figure 2, and sample analyses are listed on table 4. The samples contained significant concentrations (46 to 70 percent) of the zeolite mineral clinoptilolite.

APPRAISAL OF MINERAL RESOURCES

The Little Humboldt River study area has no identified mineral resources. However, two groups of mining claims located for gold extend into the study area. Diatomite occurs near the north end, and zeolite occurs within the study area.

Presently (1985) many of the open pit mines in Nevada are mining ore grades below 0.10 oz/ton gold (3.4 ppm), with heap leach ore grades as low as 0.026 oz/ton gold (0.9 ppm) (Lowe and others, 1985, p. 44). Commonly, at these deposits, faulting and/or brecciation provide the channel way for the localizing of epithermal processes and ore formation. Also associated with many of these disseminated gold deposits are halos of anomalous gold, mercury, and arsenic concentrations where hydrothermal activity has, to a lesser degree, affected a large volume of rock away from and enclosing the localizing structure or ore body.

No ore grade concentrations were encountered in the study area. The highest gold concentration in a USBM sample from the study area was 0.218 ppm and from a company sample, 0.595 ppm. However, three areas within the study area have anomalous gold concentrations (one with anomalous mercury and arsenic), pervasive weak hydrothermal alteration, and some localized brecciation and intense alteration, all of which indicate a resource may be present. The three areas where further study might disclose gold resources are: 1) the south side of the study area that includes the CR claim group; 2) areas of silicification and alteration along the entire length of Castle Ridge, with special attention given to the contact between the dark-greenish, andesitic rocks and dark red rhyolite; and 3) the area of First and Snowstorm Creeks along the western study area boundary where silicification and propylitic alteration were observed. This last area may extend as far southeast as Winters Creek and as far north as 2.5 mi north of First Creek.

The three zeolite outcrops examined in the study area require drilling to determine size. Samples contained 46 to 70 percent zeolite (clinoptilolite). Grades as low as 40 percent have been found to be suitable for crude agricultural purposes. However, the abundance of high-grade zeolite deposits (on the order of 90 percent) would require competing low grade deposits to be close to markets. The diatomaceous bed north of the study area contains 70 to 73 percent silica; commercial diatomite usually has a silica content of over 86 percent (Kadey, 1973, p. 876). However, processing (calcining) of this material may decrease the contaminants and significantly increase the relative silica content. Further study is required to confirm the estimated size of the occurrence (43,000 tons) and to determine whether this material can be refined to commercial grade. While the analytical methods used for this study are

suitable for screening the general quality of material, the most reliable assessment of diatomite and zeolites involves bulk sampling and detailed physical and chemical tests for specific end uses (Glen Teague, oral commun., 1986).

Oil and gas leases occur 2.5 miles north of the study area, but the area is rated as having a zero potential for petroleum (Sandberg, 1983).

TABLE 1.--Data for USBM hardrock samples

[N, none detected]

Sample No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
			CR claim group		
37	Select	--	From prospect pit: pieces of altered rhyolite and rhyolite breccia with quartz veinlets, fine disseminated pyrite, and iron-oxide stains on fracture surfaces----------	0.026	N 2/
38	Chip--	2.9	From prospect pit: across light gray, silicified and altered, porphyritic volcanic rock with white and gray vein quartz and some brecciated material----------	N 3/	N
39	Grab--	--	From prospect pit: highly silicified and altered volcanic rock with chert-like appearance is light tan to nearly white in color and has some brecciated material----------	.027	N
40	do----	--	Same as sample 39 except some iron-oxide stains on fracture surfaces and some alunite-------	.023	N
41	Select	--	From prospect pit: pieces of altered rhyolite with vein quartz and rhyolite breccia cemented by vein quartz and pyrite----------	.045	0.520
42	Select	--	From dump of caved 25-ft adit: pieces from a 1-in.-thick vein of white to gray quartz with disseminated, fine- to moderately-coarse pyrite, iron-oxide pseudomorphs after pyrite, and iron-oxide stain on fracture surfaces, is enclosed in altered and silicified rhyolite.	.218	.740

TABLE 1.--Data for USBM hardrock samples--Continued

Sample No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
			CR claim group -- Continued		
43	Select	--	Float composed of slightly altered tuff and rhyolite with minor quartz veinlets------	N	N
			Snow claim group		
19	Grab--	--	From prospect pit: light colored, silicified, and altered porphyritic volcanic rock with iron-oxide stain on fracture surfaces and as disseminated splotches throughout groundmass----------	N	N
20	do----	--	From prospect pit: light colored, silicified, and altered porphyritic volcanic rock with quartz veinlets and iron-oxide stain along fracture surfaces--	0.048	1.744
21	do----	--	From prospect pit: light colored, altered porphyritic volcanic rock with quartz cemented breccia and gray and white vein quartz----------	5.599	119.00
22	Random chip--	--	Green and tan, very fine-grained and glassy volcanic ash with rounded, cobble-size pieces of porphyritic, black, volcanic glass. Some alteration shows as silicification such as quartz veinlets, crystalline quartz in vugs, jasper, and some breccia----------	.021	N
23	Chip--	1.7	Dark gray, porous, layered, volcanic ash which is very fine-grained and glassy with chalcedony fillings and bands---	.023	N

TABLE 1.--Data for USBM hardrock samples--Continued

Sample No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
			Snow claim group -- Continued		
24	Random chip--	--	Green and tan, very fine-grained and glassy volcanic ash with rounded, cobble-size pieces of porphyritic, black, volcanic glass and disseminated, iron-oxide-stained splotches---------	0.021	N
			JMC and Red claim groups		
44	Random chip--	--	From prospect pit: iron-oxide-stained, altered, volcanic rock with disseminated iron-oxide pseudomorphs after pyrite-------	.023	1.901
45	do----	--	From prospect pit: iron-oxide-stained, altered, and silicified volcanic rock-----------------	.359	1.821
46	do----	--	do-----------------------------	.020	N
47	Select	--	From prospect pit: silicified and altered volcanic shatter breccia cemented by gray quartz; contains disseminated pyrite-----------	.025	.420
48	do----	--	From prospect pit: altered, slightly silicified volcanic breccia with chlorite-rich matrix------------------------	.019	N
49	do----	--	From prospect pit: silicified and altered volcanic rock, and volcanic breccia with some comb quartz and disseminated pyrite.	N	N
50	do----	--	Silicified and altered volcanic rock with disseminated pyrite--	.021	N
51	Random chip--	--	From prospect pit: silicified and altered volcanic rock------	.019	N

TABLE 1.--Data for USBM hardrock samples--Continued

Sample No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
			JMC and Red claim groups -- Continued		
52	Random chip	--	From prospect pit: silicified and altered volcanic rock------	N	N
53	do----	--	Iron-oxide-stained, altered, and silicified volcanic rock with cubic voids after pyrite-------	N	N
			Other metallic mineral occurrences		
5	Random chip--	--	Light colored, porous, ash layer between two dark-red rhyolite layers------------------------	N	N
6	do----	--	From prospect pit: dark gray, locally iron-oxide-stained, porphyritic rhyolite----------	0.018	N
7	do----	--	Dark red, porphyritic ryholite--	N	N
9	Chip--	1.3	Greenish-tan to dark-green silicified and altered volcanic ash----------------------------	N	N
10	do----	15.0	do----------------------------	N	N
11	Random chip--	--	Sample of scattered outcrops of gray to dark greenish gray jasper with quartz-crystal-lined vugs.	.019	N
12	Chip--	7.0	Tan to greenish gray volcanic rock, with some veinlets and blebs of jasper and opaline material and some iron-oxide stains------------------------	N	N
13	do----	2.2	Greenish tan and gray jasper with seams of white and red opaline material--------------	.018	N
14	do----	1.2	Tan, brown, red, and green jasper with some white opaline material----------------------	.018	N

TABLE 1.--Data for USBM hardrock samples--Continued

Sample No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
			Other metallic mineral occurrences -- Continued		
15	Random chip--	--	Gray, tan, and green altered volcanic rock with some white opaline material----------	0.017	1.326
16	do----	--	Slab-shaped talus of dark red, porphyritic ryholite----------	.020	N
17	Random chip	--	Dark red, silicified volcanic rock with some light-colored altered material at contact between dark green andesite and red rhyolite----------	.049	.975
18	Chip--	1.5	From prospect pit: red, tuffaceous breccia cemented by earthy hematite and limonite----------	N	N
25 4/	do----	5.0	Layer of porous, light-colored volcanic ash----------	.019	N
26	Random chip--	--	Fractured, light-colored, porphyritic volcanic rock-------	.020	.480
27	Select	--	Silicified material at contact between dark red pophyritic rhyolite (above) and a dark-greenish, porphyritic andesite (below); chalcedony, opaline material, and vein quartz in both rock types----------	.042	N
28	do----	--	Same contact as sample 27; breccia with light tan, altered volcanic fragments in a dark red jasperoid matrix----------	.135	.540
29	do----	--	Nearly white to gray, altered volcanic rock with a greenish cast----------	.018	N

TABLE 1.--Data for USGM bedrock samples--Continued

No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
15	Random chip--	--	Gray, tan, and green altered volcanic rock with some white opaline material----------	0.017	1.25
16	do----	--	Slab-shaped talus of dark red, porphyritic rhyolite----------	.020	N
17	Random chip	--	Dark red, silicified volcanic rock with some light-colored altered material at contact between dark green andesite and red rhyolite----------	.040	.575
18	Chip--	1.5	From prospect pit: red, tuffaceous breccia cemented by earthy hematite and limonite----------	N	N
25 2/	do----	5.0	Layer of porous, light-colored volcanic ash----------	.010	N
26	Random chip--	--	Fractured, light-colored, porphyritic volcanic rock----------	.020	.400
27	Select	--	Silicified material at contact between dark red porphyritic rhyolite (above) and a dark-greenish, porphyritic andesite (below); chalcedony, opaline material, and vein quartz in both rock types----------	.042	N
28	do----	--	Same contact as sample 27; breccia with light tan, altered volcanic fragments in a dark red laterite matrix----------	.135	.540
29	do----	--	Nearly white to gray, altered volcanic rock with a greenish cast----------	.012	N

TABLE 1.--Data for USBM hardrock samples--Continued

Sample No. (fig. A-1)	Type	Length (ft)	Description	Gold (ppm) 1/	Silver (ppm)
			Other metallic mineral occurrences -- Continued		
31	Random chip--	--	Light colored, porous, welded, glassy, volcanic ash----------	N	N
32 5/	do----	--	Light colored, porous, volcanic ash----------	N	N
33 6/	do----	--	From 5-ft-wide crushed zone of red, flow-banded rhyolite-------	N	N
34	Select	--	At contact between dark-greenish, andesitic volcanic rock and red rhyolite breccia having light-colored, altered, volcanic-rock fragments in a dark red jasperoid matrix----------	0.023	N
35	do----	--	Breccia with altered, light tan, and dark red, porphyritic rhyolite fragments in dark red jasperoid matrix----------	.017	N
36	do----	--	Reddish brown and orange jasperoidal to opaline material.	.018	N

1/ ppm: parts per million by weight; 1 ppm equals 0.029 troy ounce per ton.
2/ Lower detection limit for silver was 0.3 ppm.
3/ Lower detection limit for gold was 0.007 ppm.
4/ Sample contained 2.8 ppm uranium.
5/ Sample contained 1.7 ppm uranium.
6/ Sample contained 0.022 percent copper.

TABLE 2.--Preliminary characterization of diatomite samples

Sample no. (fig. A-1)	Microscopic examination (genera, condition of diatoms, and contaminants)	Sample type	Sample length (ft)	Crude 1/ consolidation	Crude 1/ color	LOI 2/ (%)	Ignited 3/ color
1	Melosira. Some whole, some sponge spicules; 10% clay and 5% volcanic ash.	Chip--	1.5	Semi-soft	Light beige	9.9	Orange
2	Melosira. Some whole; 5% to 10% clay and 5% to 10% volcanic ash.	Chip--	1.0	Semi-soft	Light gray	8.0	Chocolate brown
3	Melosira, fragilaria, and synedra. Fragmented; 30% clay, 5% quartz and some carbonate.	Random chip--	20.0	Loose-soft	Light beige, gray and greenish tan	4/	4/

1/ Crude: condition prior to ignition.
2/ LOI: loss on ignition; the loss in weight which results from heating a sample to 1,000 °C--includes organic materials, given in percent (%).
3/ Ignited: condition after ignition.
4/ No detailed analyses; diatoms too fragmented, and there is too much clay impurity.

TABLE 3.--Chemical analyses of diatomite samples

Sample No. (fig. A-1)	Chemical analyses								
	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	TiO_2 %	CaO %	MgO %	Na_2O %	K_2O %	P_2O_5 %
1	73.1	6.6	3.2	0.3	1.7	0.99	1.4	0.45	0.06
2	70.1	11.2	2.9	.48	1.2	.81	2.1	1.1	.10
3 1/									

1/ No detailed analyses; diatoms too fragmented, and there is too much clay impurity.

TABLE 4.--Description and analyses of zeolite samples

Sample no. (fig. A-1)	Sample Type	Length (ft)	Description	Clinoptilolite 1/ (%)	NH_4^+ Exchange 2/ (mlq/g)	Major 3/ impurities	Minor 4/ impurities
4	Grab	--	Light tan, porous, altered tuff with greenish cast. Similar looking outcrops common in a half square mile area---------	46	0.56	cristobalite 5/	amorphous 6/
8	Chip	5.0	Light tan, porous, altered tuff with greenish cast. Outcrop appears to be over 20 ft thick.	63	.93	amorphous	cristobalite
30	Random chip	--	Very light colored, nearly white, porous, altered tuff with greenish cast. Sampled over a 70 ft slope distance representing about 20 ft of thickness------	70	.91	quartz	feldspars

1/ Clinoptilolite: a zeolite mineral, given in percent (%).
2/ NH_4^+ exchange: ammonium cation exchange capacity in millequivalent per gram (mlq/g).
3/ Major: approximately 30 to 100 percent.
4/ Minor: approximately 10 to 30 percent.
5/ Cristobalite: a silicate mineral.
6/ Amorphous: a mineral lacking crystal structure, such as glass.

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APPENDIX A.--GEOLOGICAL AND GEOCHEMICAL DATA FROM THE CR CLAIM GROUP

A mining company supplied the USBM with preliminary geologic data from the study area and the CR claim group. The data consisted of a geologic map, rock alteration map, 65 geochemical rock sample analyses, and 261 reconnaissance geochemical stream-silt sample analyses. Figure A-1 shows 78 stream-silt sample localities that are from within or adjacent to the study area. Figures A-2 and A-3 are geologic and rock alteration maps, respectively, adapted from the company maps. Figures A-4, A-5, and A-6 are graphic illustrations summarizing USBM interpretations of the 65 geochemical rock sample analyses.

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FIGURE A-1. – Prospects, claims, USBM sample localities, and company stream silt sample localites in and adjacent to the Little Humboldt River study area, Elko County, NV

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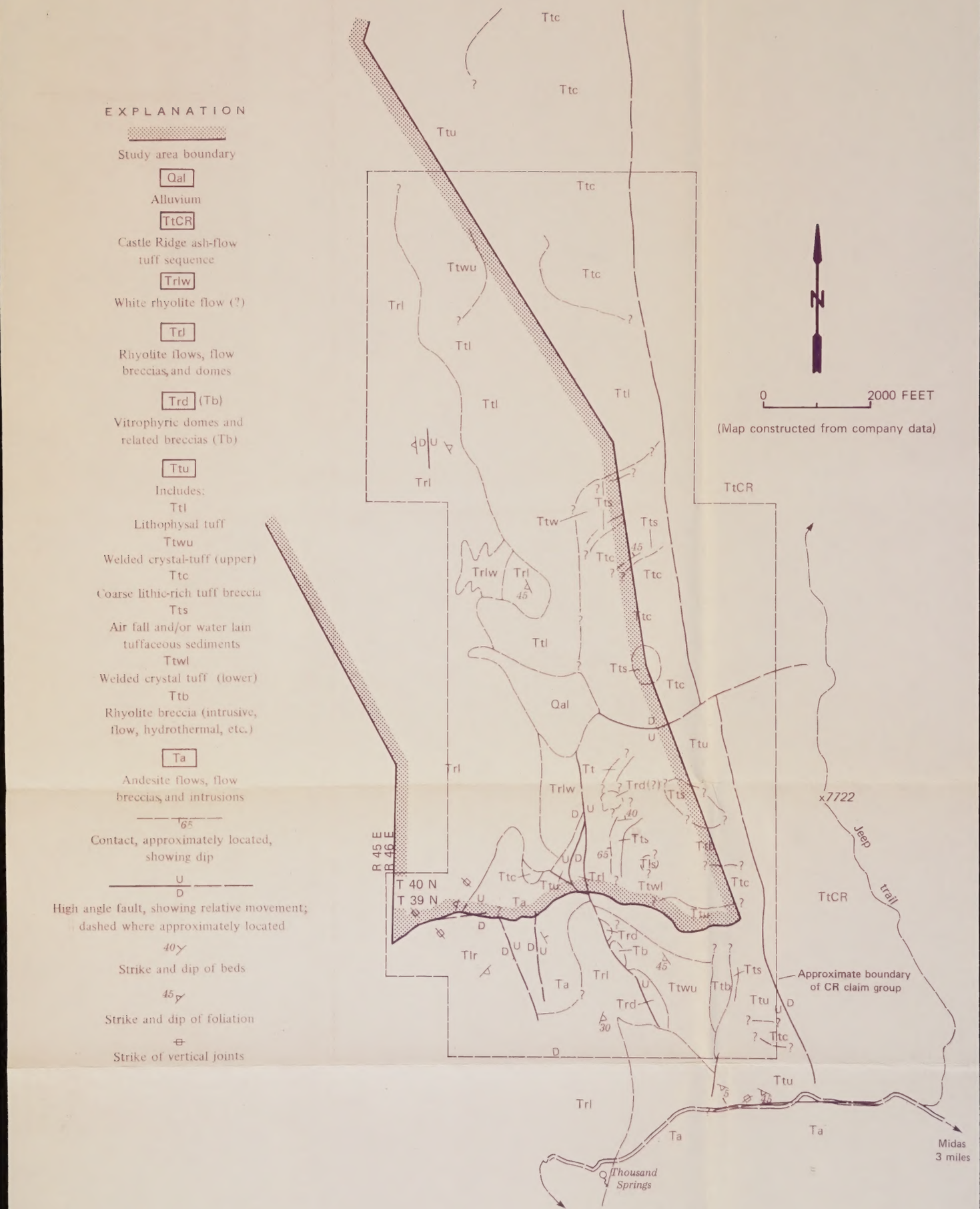

FIGURE A–2 – Geologic map of the CR claim group

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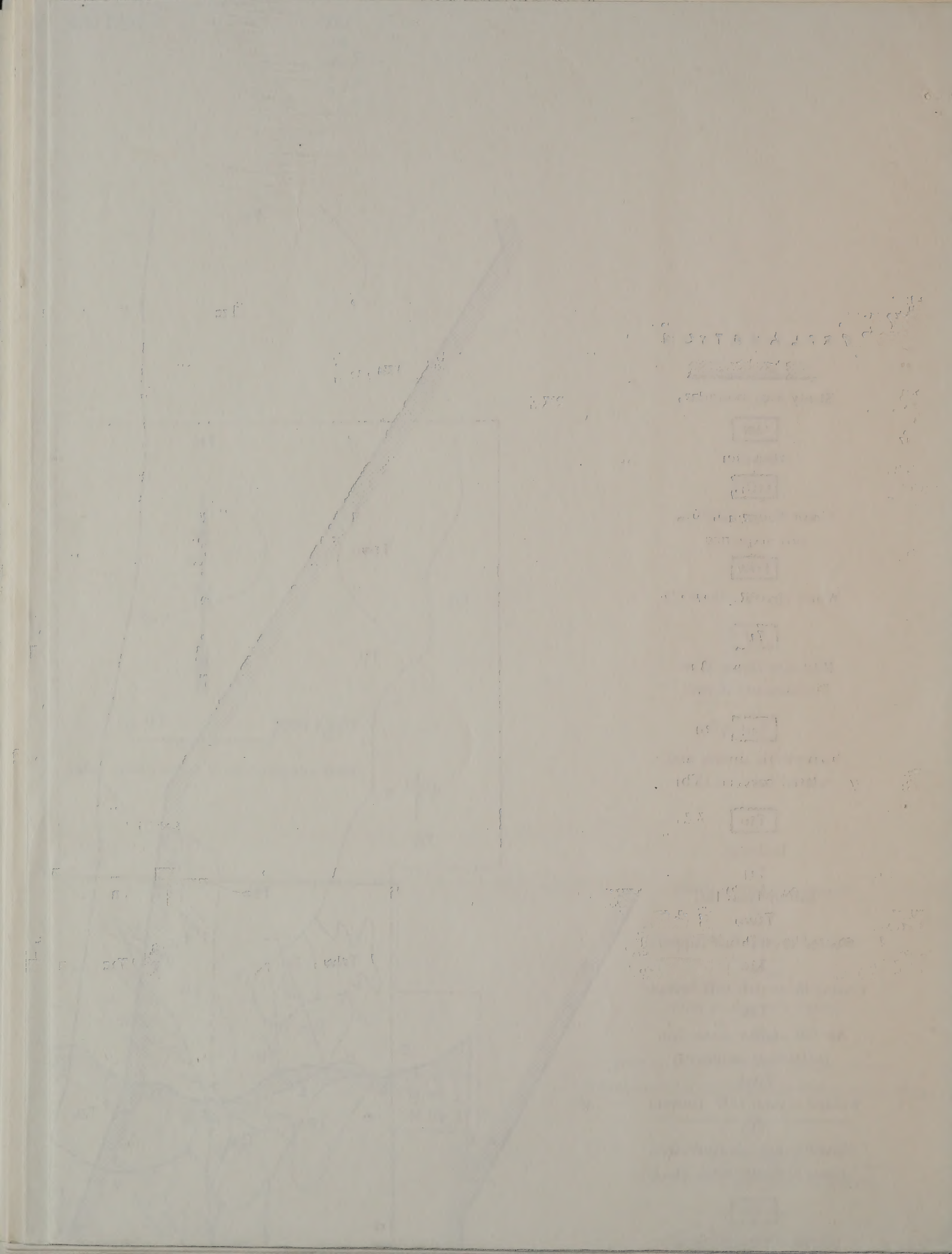

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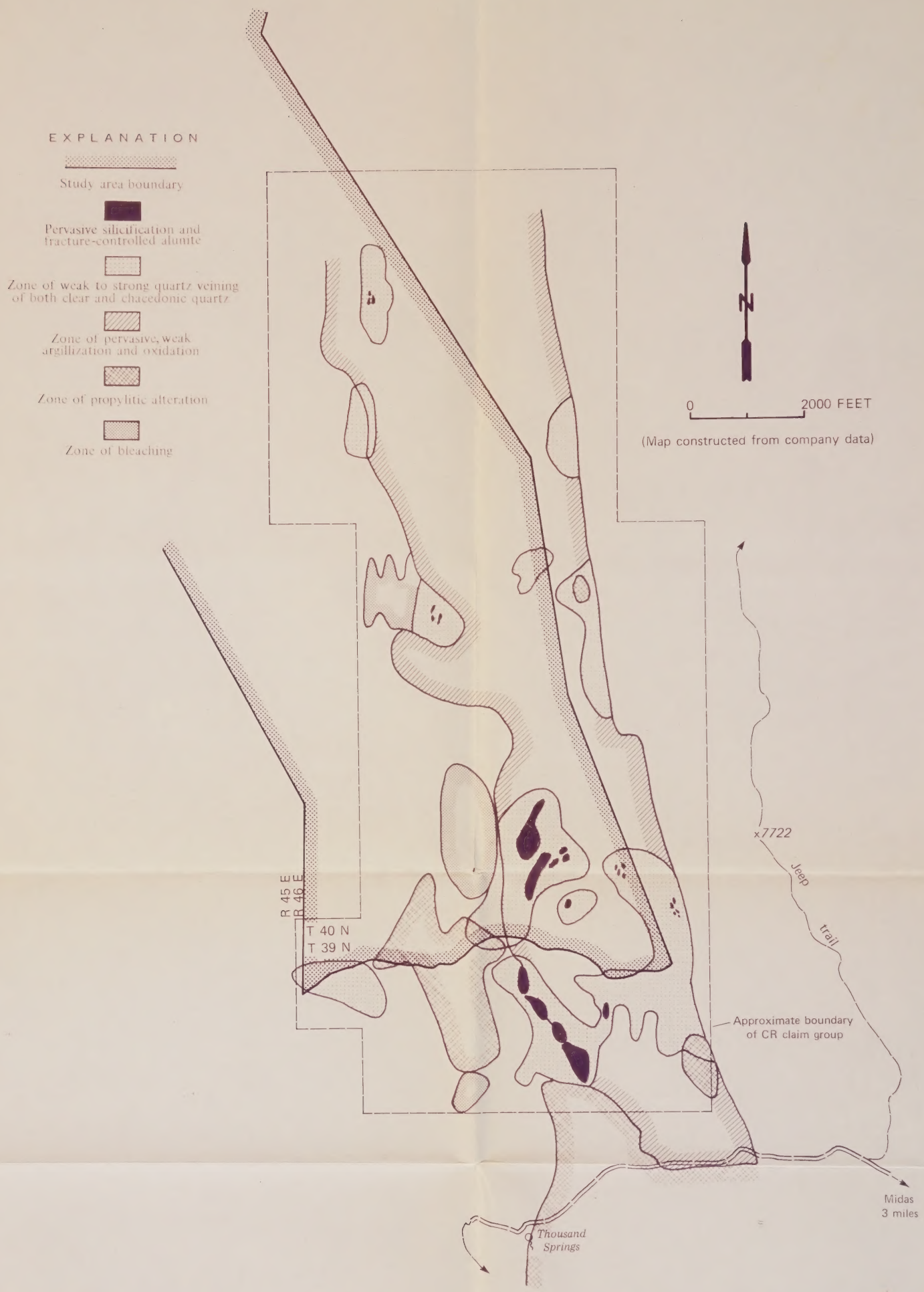

FIGURE A–3 – Rock alteration map of the CR claim group

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EXPLANATION

Study area boundary

—50— Isograds showing gold in parts per billion (ppb)

•—30 Highest gold concentration (ppb)

• Sample localities

N

0 2000 FEET

(Map constructed from company data)

R 45 E
R 46 E
T 40 N
T 39 N

Jeep trail

x7722

Approximate boundary of CR claim group

Midas
3 miles

Thousand Springs

FIGURE A–4 – USBM interpretations of geochemically anomalous gold concentration in the CR claim group

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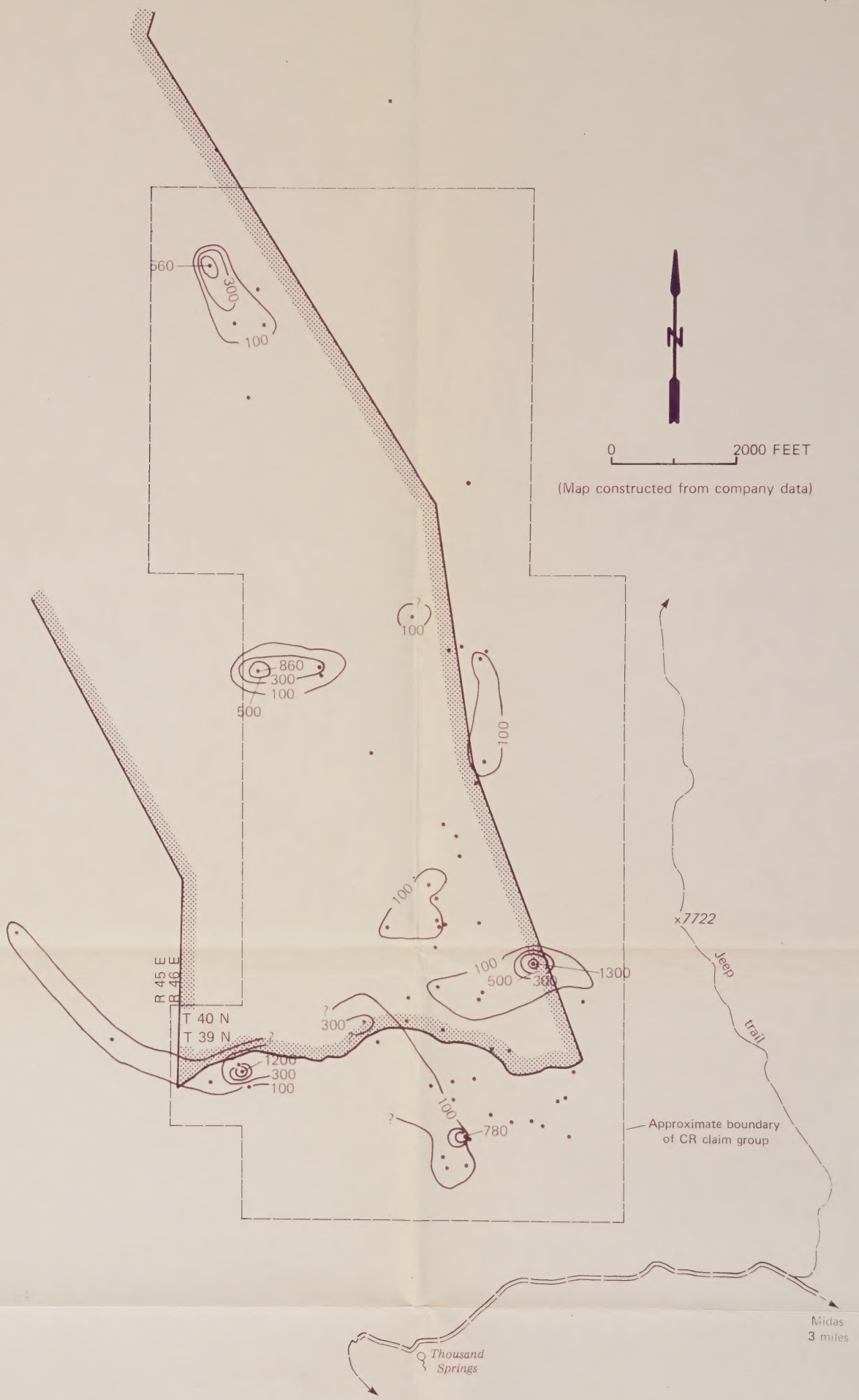

FIGURE A–5 — USBM interpretations of geochemically anomalous mercury concentration in the CR claim group

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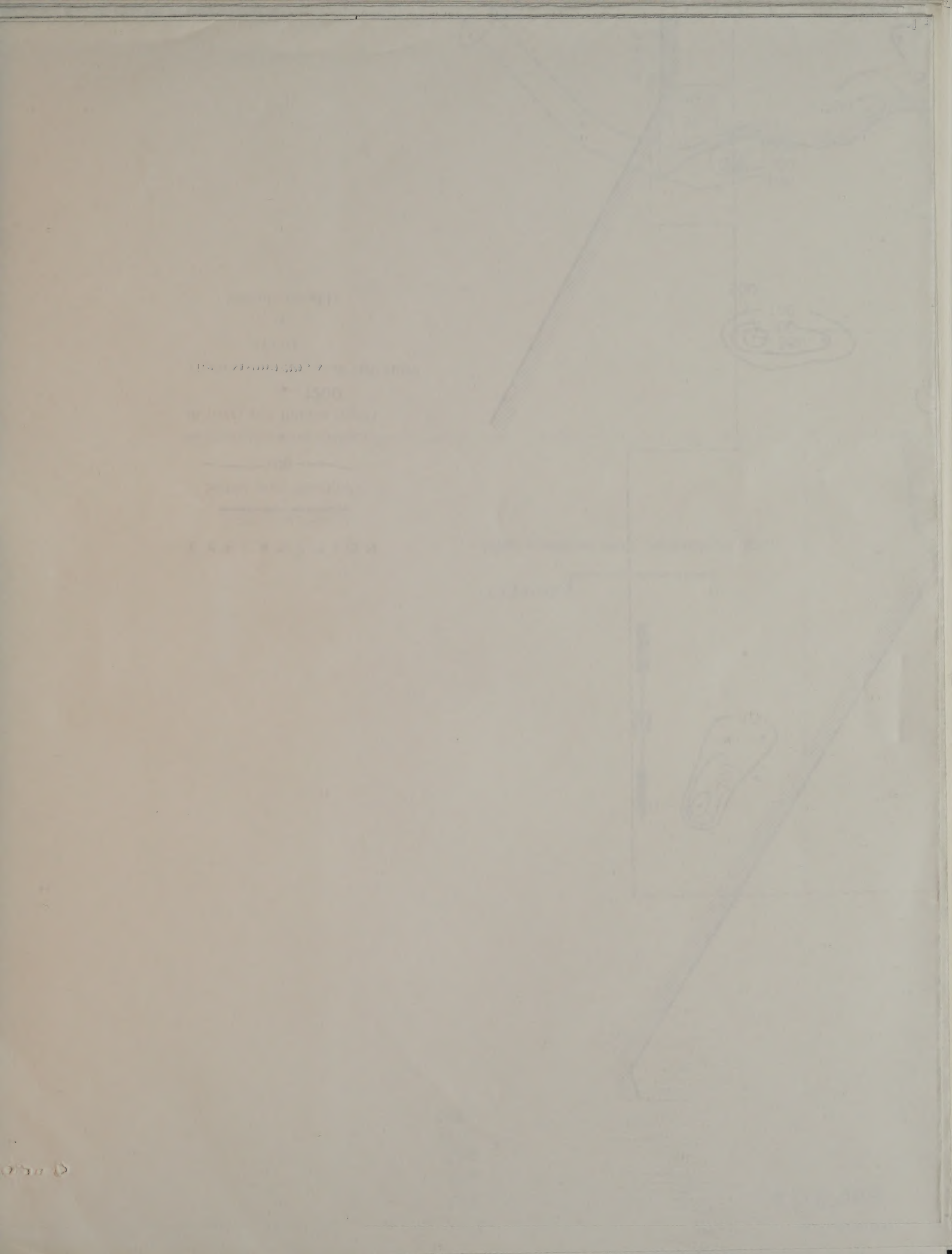

88077073

TN
24
.N3
G33
1987

EXPLANATION

Study area boundary

20

Isograds showing arsenic in parts per million (ppm)

85

Highest arsenic concentration (ppm)

Sample locality

N

0 2000 FEET

(Map constructed from company data)

R 45 E
R 46 E

T 40 N
T 39 N

×7722

Jeep trail

Approximate boundary of CR claim group

Midas
3 miles

Thousand Springs

FIGURE A–6.—USBM interpretations of geochemically anomalous arsenic concentration in the CR claim group

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